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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/614,916	07/07/2003	Paul J. Schuele	3961.5US (94-0083.04/US)	7875
24247	7590	12/13/2004	EXAMINER	
TRASK BRITT P.O. BOX 2550 SALT LAKE CITY, UT 84110			NGUYEN, HA T	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 12/13/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/614,916

Applicant(s)

SCHUELE ET AL.

Examiner

Ha T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 25 October 2004.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-22 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-22 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All   b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |   |
|---|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)  | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>07-07-03(p1)</u> . | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Notice to applicant*

1. Applicants' Amendment and Response to the Office Action mailed 7-23-4 has been entered and made of record.

The preliminary amendment filed 12-01-03 has been entered and made of record.

### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103<sup>©</sup> and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsang et al. (USPN 5353246, hereinafter "Tsang") in view of Huang et al. (USPN 5635423, hereinafter "Huang") and Iranmanesh (USPN 55149000).

Referring to Figs. 1-10 and related text, Tsang discloses a method of forming a barrier layer comprising providing a polysilicon layer 3A having a surface in a portion of a dielectric layer 4 of an integrated circuit; depositing a layer of titanium 6 on at least a portion of the surface of the polysilicon layer; depositing a layer of amorphous material 9 on at least a portion of the layer of titanium ; and depositing a layer of titanium compound 10 on the layer of amorphous material (See col.3, line 30 - col. 4, line 39 ).

But it does not disclose expressly that the polysilicon layer is a polysilicon plug and that the titanium compound deposited on the amorphous material is a TiN layer.

However, the missing limitations are well known in the art because Huang discloses that conductive wiring can be formed by filling an opening with a conductive material or by building up a metal wiring layer then filling in the interwiring spaces with a dielectric material (See col. 1, lines 60-67) and Iranmanesh discloses that TiW and TiN are equivalent materials (see par. bridging cols. 6 and 7).

Therefore, it would have been obvious to combine Tsang with Huang and Iranmanesh to obtain the invention as specified in claims 1 and 12 .

4. Claims 1 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iranmanesh in view of Tsang.

Referring to Figs.4A-4F and related text, Iranmanesh discloses a method of forming a barrier layer comprising: providing a conductive plug 48 having a surface in a portion of a dielectric layer 47 of an integrated circuit; depositing a layer of titanium 52 on at least a portion of the layer of the conductive plug 48; depositing a layer of amorphous material 44A on at least a portion of the layer of titanium; and depositing a layer of titanium nitride 45 over at least a portion of the layer of Ti (See col. 6, lines 16-21, lines 29-54par. bridging cols. 6 and 7 ). Iranmanesh also discloses the conductive plug is of W, Al, Cu or other suitable materials (see col. 7, lines 10-14).

But it fails to disclose expressly that the plug is of polysilicon .

However, the missing limitation is well known in the art because Tsang discloses this feature as shown above. A person of ordinary skill is motivated to modify Iranmanesh with Tsang to obtain a device using a readily available, conventionally used material.

5. Claims 3-6, 9, 11, 14-17, 20, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iranmanesh in view of Tsang , as applied above, and further in view of Katz (USPN 5089438)

The combined teaching of Iranmanesh and Tsang discloses substantially the limitations of claims 3-6, 9, 11, 14-17, 20, and 22, as shown above.

But it fails to disclose expressly the details about the formation of Ti nitride.

However, the missing limitations are well known in the art because Katz discloses [Re claims 3-6 and 14-17] the steps of: placing the dielectric layer of an the integrated circuit in a low-pressure chemical vapor deposition chamber; providing a carrier atmosphere in the low-pressure chemical vapor deposition chamber having a pressure in a-range of between about 0.1 Torr and about 100 Torr; providing a precursor compound in the low-pressure chemical vapor deposition chamber; and heating the dielectric layer to a temperature in a range of between about 200°C and about 600°C ; wherein the carrier atmosphere comprises a mixture including at least one gas selected from a group consisting of a noble gas, nitrogen and hydrogen; wherein the precursor compound comprises an organo-metallic compound; wherein the precursor compound comprises tetrakis-dialkylamido-titanium; [Re claims 9 and 20 ] wherein the depositing the layer of amorphous material comprises depositing a layer of substantially amorphous material substantially without crystal grain boundaries therein; and [Re claims 11 and 22 ] wherein the precursor compound comprises a sole precursor (see Background, Summary, and col. 3, lines 10-65).

A person of ordinary skill is motivated to modify Iranmanesh and Tsang with Katz to obtain a device using a flexible and easily controlled deposition method appropriate for a specific device of desired properties.

Therefore, it would have been obvious to combine Iranmanesh with to obtain the invention as specified in claims .

6. Claims 1, 2, 7- 9, 12, 13, and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sandhu et al. (USPN 5381302, hereinafter "Sandhu) in view of Sandhu et al. (USPN 6107105, hereinafter "'105").

Referring to Figs. 1-12B and related text, Sandhu discloses [Re Claims 1 and 12] a method of forming a barrier layer comprising: providing a polysilicon layer having a surface in a portion of the dielectric layer of an integrated circuit; depositing a layer of titanium 66 on at least a portion of the layer of the polysilicon plug 40 (see fig. 7); and depositing a layer of titanium nitride 75 over at least a portion of the layer of Ti (See col. 5, lines 29-54);

[Re Claims 2 and 13] forming a recess in a portion of the polysilicon plug; forming a well including a portion of the dielectric layer above said polysilicon plug; depositing portions of the layer of titanium and the layer of titanium nitride within the well and over at least a portion of a surface of the dielectric layer ; and removing at least a portion of each of the layer of titanium and the layer of titanium nitride deposited over said at least a portion of the surface of the dielectric layer (see Figs. 6-10B);

[Re Claims 7 and 18] wherein removing the at least a portion of each of the layer of titanium, the layer of amorphous material, and the layer of titanium nitride deposited over the at least a portion of the surface of the dielectric layer comprises planarizing the dielectric layer to remove at least the portion of the layer of titanium, the layer of amorphous material, and the layer of titanium nitride deposited over said at least a portion of the surface of the dielectric layer (see Figs. 10A and 10B).

But it does not disclose expressly depositing a layer of amorphous material between the layer of titanium and the titanium nitride and depositing a layer of titanium carbonitride having amorphous structure substantially without grain boundaries therein.

However, the missing limitations are well known in the art because '105 discloses the use of an amorphous TiN barrier (See col. 2, lines 54-67), when considering the amorphous TiN barrier to be composed of two layers, the lower layer would correspond to the claimed amorphous material and the upper layer would correspond to the claimed titanium nitride; and

[Re Claims 8-9 and 19-20] that the titanium nitride contains carbon atoms or amorphous titanium carbonitride inherently having no grain boundaries (See col. 2, lines 54-67) .

Therefore, it would have been obvious to combine Sandhu with '105 to obtain the invention as specified in claims 1, 2, 7-9, 12, 13, and 18-20.

7. Claims 3-6, 14-17, 10, 11, 21, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sandhu in view of '105, as applied to claims 1, 2, 7-9, 12, 13, and 18-20 above, and further in view of Sandhu et al. (USPN 5571572, hereinafter “'572”).

The combined teaching of Sandhu and '105 discloses substantially the limitations of claims 3-6 and 14-17, 10, 11, 21, and 22, as shown above.

But it does not disclose expressly the details about temperatures, pressure, carrier and precursor gases and ratio of carbon to nitrogen in the titanium carbonitride layer .

However, the missing limitations are well known in the art because '572 discloses these features (See col. 4, lines 46-66 and col. 5, lines 41-52).

A person of ordinary skill is motivated to modify Sandhu and '105 with '572 to obtain conformal barrier layer (see '572, col. 3, lines 1-4).

Therefore, it would have been obvious to combine Sandhu and '105 with '572 to obtain the invention as specified in claims 3-6 and 14-17, 10, 11, 21, and 22.

### ***Response to Amendment***

8. In view of applicants' filing of the two Terminal Disclaimers, the double patenting rejections of claims 1-22 have been withdrawn.

The examiner will withdraw the rejections using Sandhu and '572 when Applicants include the phrase "at the time the invention was made", as required by 35 U. S. C 103(c), in the statement concerning the common ownership.

Applicants' arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that the combination of Tsang, Huang and Iranmanesh does not teach the claimed invention, and there is no motivation to combine the references. The examiner disagreed. As shown in the rejection, Tsang discloses substantially the limitations of the independent claims 1 and 12, Huang and Iranmanesh are used only to substitute an equivalent process of forming a conductive contact and an equivalent diffusion barrier material. It would have been obvious to use an equivalent process of forming the conductive when this process better fits in the process flow and use an equivalent diffusion barrier material when the material is readily available or used in other process, this would improve efficiency and reduce material cost. Applicants arguments concerning the high temperature are deemed irrelevant since there is no limitations concerning temperature in claims 1 and 12.

Applicants argued that the combination of Iranmanesh and Tsang does not teach the claimed invention, and there is no motivation to combine the references. The examiner disagreed. As shown in the rejection, Iranmanesh discloses substantially the limitations of the

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independent claims 1 and 12, Tsang was used to show that polysilicon is also a material commonly used and readily available in a semiconductor plant. Depending on the requirements concerning cost, speed, quality or reliability of each application, using a well known conductor with established manufacturing record would be obvious for an ordinary artisan. At least the corrosion or contamination problems caused by the precursors used in the fabrication of W plug can be avoided. The expectation of some advantage is the strongest rationale for combining references (MPEP 2144). Note that the test of obviousness under 35 USC 103 does not require an expressed suggestion of the claimed invention in the prior art. All that is required to show obviousness is that the claimed invention would have been made obvious by applying knowledge clearly present in the prior art. *In re Rosselet*, 347 F.2d 847, 146 USPQ 183 (CCPA 1965); *In re Sheckler*, 438 F.2d 999, 168 USPQ 716 (CCPA 1971); *In re Sovish*, 769 F.2d 738, 226 USPQ 771 (Fed. Cir. 1985).

Therefore the combination of the applied references does teach or make obvious all the limitations of claims 1-22.

### ***Conclusion***

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for response to this final action is set to expire THREE MONTHS from the date of this action. In the event a first response is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event will the statutory period for response expire later than SIX MONTHS from the date of this final action.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The



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examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John F. Niebling, can be reached on (571) 272-1679. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Ha Nguyen

Primary Examiner

12- 9- 04